Atmospheric Science Program:

DOE Research Aircraft Facility

Gulfstream 159 Aircraft for Airborne Atmospheric Research

W.R. Barchet

Pacific Northwest National Laboratory

June 11, 2002

DOE Research Aircraft Facility

Grumman Gulfstream 159 (G-1) twin turboprop aircraft

DOE Research Aircraft Facility

- A DOE/OBER/ESD resource for atmospheric chemistry & aerosol research
- Instrument development, testing, and application; field study deployment
- Requests for access reviewed and recommended by Advisory Panel
- Priority given to DOE/OBER/ESD projects
- Contact W. R. Barchet for more information or application for flight hours:

e-mail: rich.barchet@pnl.gov
phone: 509-372-6158
fax: 509-372-6168

Attributes of the G-1 Aircraft

- Dimensions: Length 20 m, Wingspan 24 m, Height 21 m, Weight 16,330 kg max
- Nominal operation: Altitude 0.5-7.5 km, Speed 80-150 m/s, Sampling speed 100 m/s, Climb 160-330 m/min
- Endurance with maximum fuel: 6 hr
- Electrical Power: 4,000 VA @ 110&220 VAC, 28 VDC
- Crew: 2 pilots, 1-4 scientists
- Cabin payload: 1,300 kg

Research Electrical Power

- Independent generator on left engine
  - 300 A @ 28VDC
- Inverters transform 28 VDC to AC voltage
  - 4000 VA @ 110 VAC, 60 Hz, 1-_
  - 4000 VA @ 220 VAC , 60 Hz, 1-_
- Belly plugs provide 110 & 220 VAC shore power
- Distribution panel divides into circuits
  - circuit breaker protected
  - multi-voltage receptacle boxes
- Pilot can “kill” research power in an emergency
  - 2000 VA @ 110 VAC available from aircraft system
- Electrical power is the most limiting resource

Instrumentation on G-1

- PNNL and collaborative
  - ANL, BNL, Battelle Columbus
  - Other research organizations
- Meteorological sensors
  - Temperature, pressure, dew point temperature
  - Gust probe vector winds
- Chemical sensors
  - Real-time: O_3, CO, SO_2, $NO/NO_2/NO_y$, H_2O, H_2O_2; VOCs via PTR-MS; H_2SO_4, HNO_3, HONO via API-MS
  - Integrating: NO_2, PAN, HCHO, VOC

Instrumentation on G-1

(continued)

- Cloud & Aerosol Microphysics
  - PCASP, FSSP, 2D aerosol/cloud size spectra
  - Total scatter/back scatter nephelometers
  - Condensation particle counters
  - Ultrafine particle counter
  - Liquid water content probe
- Radiation
  - UV/solar/IR radiometers
  - Up/down-looking IR thermometers

Instrumentation on G-1

(continued)

- External instrumentation collaboration
  - BNL: NO_x/NO_y, H_2O_2, HCHO, Aerosol chemistry, Ultrafine sizing
  - BCO: API-MS, PAN-GC, VOC
  - ANL: VOC, VOC-GC, NO_2/PAN
  - U-WA: CFVI, CCN, B_{scat}
  - U-NV/DRI: CCN spectrometer
  - PNNL: PTR-MS, TRAC

BCO API 365 MS/MS

Instrumentation on G-1

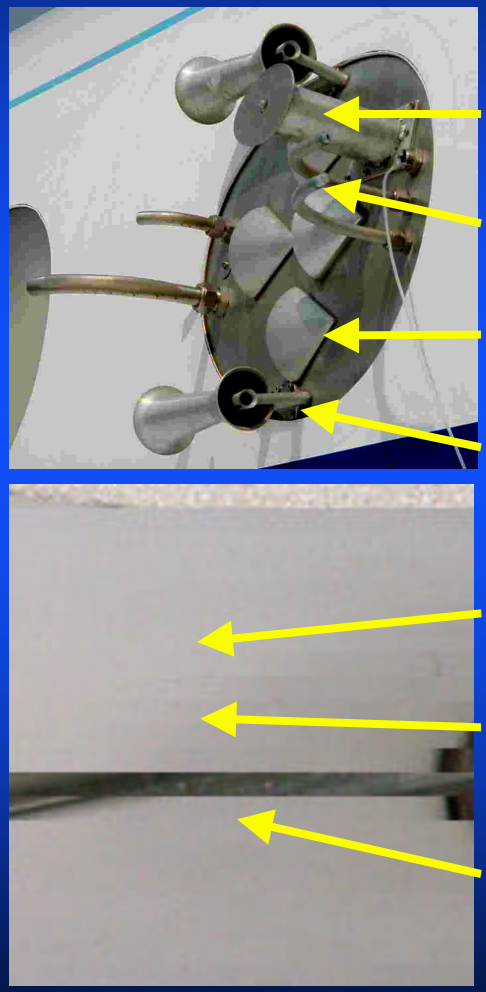
(continued)

View forward

View aft

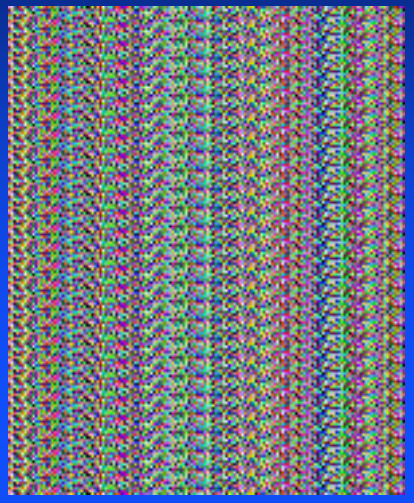
Inlets and Exhausts for Research Instruments

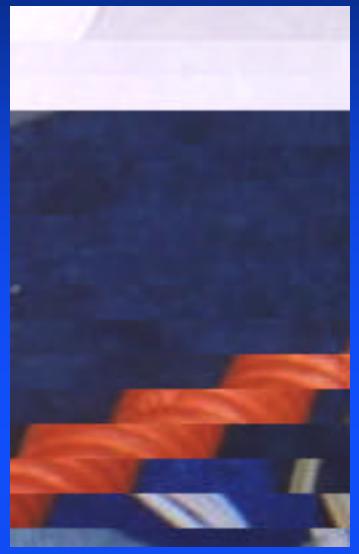
- Inlets need to be
  - chemically inert (Teflon, SS)
  - insensitive to angle of attack
  - isokinetic for particles
- Exhausts are needed to
  - remove excess heat
  - vent sensor trace gases
- Venturis needed to draw sample air through some instruments

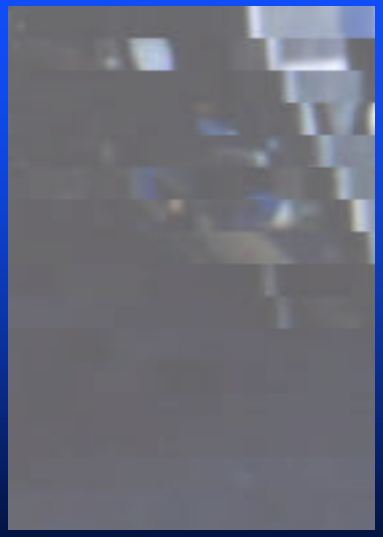


Instrumentation Racks

- Racks fastened to floor tracks
  - two on left
  - three on right
- Racks come in different sizes
  - Single-wide: 22”Wx19”Dx42”H
  - Double-wide: 42”Wx24”Dx42”H
- Racks protect
  - instruments from mechanical shock & accidental jolts
  - flight crew from injury
- Racks withstand high g-forces
  - turbulence
  - landings



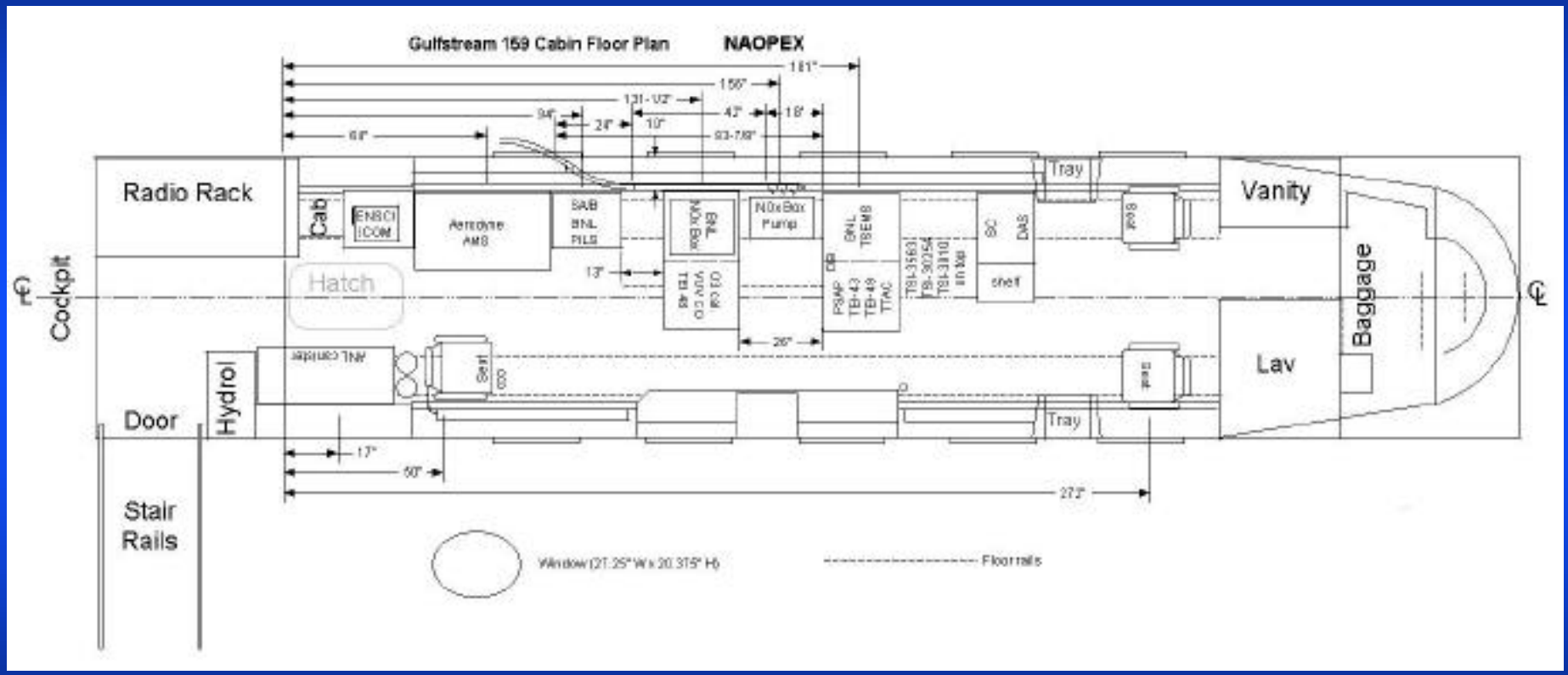




Data Acquisition System

- Science & Engineering Associates M200
- 64 channels of analog (±5 VDC) input
  - space available for another 32 channels
- Special interface cards for
  - FSSP, PCASP aerosol probes
  - TANS/Vector attitude GPS
- Output to 8 mm tape or save on hard disk
- Flat panel display for real-time monitoring
  - Aircraft position superimposed on map
  - Strip-chart trace of selected parameters
  - Parameter versus Altitude for profiles

Cabin Configuration for FY02 Field Studies



2700 lb equipment

4 scientific crew

5000 VA @ 110 VAC

2900 VA @ 220 VAC

ASP Facility: Gulfstream 159

Locations of ACP Projects Using the DOE RAF G-1